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USSR Report

MATERIALS SCIENCE AND METALLURGY

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UDC: 621.785.78:669.715

SELECTION OF OPTIMAL TWO-STAGE AGING CONDITIONS FOR CAST Al-Mg-Zn ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 11, Nov 83 pp 56-59

DOLZHANSKIY, Yu. M., CHERKASOV, V. V., POBEZHIMOV, P. P. and PANCHENKO, P. V.

[Abstract] A study was made of the effect of two-stage aging on the mechanical properties of Al-6.5% Mg-2.5% Zn with slight additions of transition group elements. The method of mathematical planning of experiments was used to select the optimal conditions for this alloy. A B_4 plan was used, with variables ranging over the following intervals: first stage temperature 16-100°C, holding time in first stage 4-20 hr, second stage temperature 150-190°C, holding time in second stage 2 to 12 hr. The optimal conditions were found to be 80°C, 12 h plus 190°C, 3 hr. For parts cast in metal molds the mechanical properties thus achieved were tensile strength 400-420 MPa, yield point 300-320 MPa, δ = 8-10%. Aging under these conditions can increase the strength properties of the alloy by an average of 15% while maintaining good ductility. Figures 2; references 3 all Russian.
[34-6508]

UDC: 669.715.620.194.2

INFLUENCE OF GRAIN BOUNDARY INCLUSION DENSITY AND RELATED FACTORS ON CORROSION CRACKING RESISTANCE OF Al-Zn-Mg AND Al-Zn-Mg-Ca ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian No 5, Sep-Oct 83
(manuscript received 3 Sep 81) pp 52-55

BURMISTROVA, O. K. and POLYANSKIY, V. M.

[Abstract] The purpose of this study was to determine the relationship between microstructural characteristics of grain boundaries and boundary areas and the corrosion cracking resistance of alloys. A laboratory 3-component alloy and commercial 4-component alloy type V93 were studied. Each was hardened from 450°C, the laboratory alloy in cold water, V93 in hot water, and aged under conditions providing significantly different corrosion crack resistance. The microstructure of the grain boundary area was studied by transmission electron microscopy of thin foils prepared by two-stage electro-polishing. It was found that in the foils prepared by V93 alloy after

exposure to laboratory air for 50 days the grain boundary segregations were replaced by pores. The resistance of the alloy to corrosion cracking was influenced not by the segregation-free zone itself, but rather by the width of a subzone which is poor in the alloying elements and in vacancies. The structure with the greatest crack resistance is that which is poorest in Mg in this area and in which the grain boundary segregations are as far apart from each other as possible. Figures 3; references 11: 4 Russian, 7 Western. [33-6508]

UDC: 620.194

LOCAL CORROSION DAMAGE TO ALUMINUM ALLOY

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 19 Dec 81) pp 55-61

SMIYAN, O. D., KOVAL', M. V., MELEKHOV, R. K., KOROBANOVA, N. L., KRUTSAN, A.M. and YAKOVCHIK, V. A., Institute of Physics and Mechanics imeni G.V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] An analysis of the thermodynamic stability of the aluminum alloys D16 and V95 is presented. The ϕ-pH equilibrium diagrams indicate thermodynamic probability of primary hydration of individual aluminum alloy components. The stability of the alloys in chloride solutions can be determined by considering the interactions of alloy components and their compounds, particularly of oxides, with chloride ions. It is experimentally demonstrated that hydrogen is absorbed by the aluminum alloys primarily in areas of plastic deformation and triaxial stresses. It then facilitates an intensification of local dissolution of areas of the metal with elevated hydrogen concentration and in the case of corrosion mechanical damage, including corrosion cracking, facilitates the appearance of microscopic cracks in advance of growing corrosion cracks. It is established that a significant increase in the corrosion cracking resistance of high strength V95 aluminum alloy in chloride solutions can be achieved by changing the texture of semifinished goods, particularly by using forged and rolled plates of the high purity alloy V95pch. Figures 3; references 15: 10 Russian, 5 Western.
[33-6508]

COATINGS

USING A DETONATION-PLASMA METHOD FOR PRODUCING COATINGS FROM METAL ALLOYS WHICH ARE AMORPHOUS IN THE SOLID STATE

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 20 Dec 82, after revision 24 Mar 83) pp 27-30

MATUKHNOV, V. M., SHMYREVA, T. P., ALTAREVA, G. I. and BAFIN, A. K., Kazan and Dnepropetrovsk

[Abstract] Combining detonation and plasma methods into a single coating deposition process makes it possible not only to fully realize the advantages of high temperature and pressure, and of chemical activity, but also to intensify phase and polymorphous as well as other physicochemical transformations. Combining these two methods also should make it possible to produce new coating materials with special properties. Such materials are alloys which have been found to have a much higher corrosion resistance when in the amorphous state than when in the crystalline state, the corrosion current being typically two orders of magnitude lower in the case of Fe-Cr-P-C alloys. Amorphization of such an alloy requires cooling at rates as high as 10^5 °C/s, which is possible only after pulverization. This can be achieved by blast-plasma treatment. An experimental study was made with the quasi-eutectic $Fe\text{-}Cr_8\text{-}P_{13}\text{-}C_7$ alloy as coating material. Colorimetric measurements by the method of differential thermal analysis and microstructural examination by the x-ray diffraction method have revealed that this process is more effective than plain blast deposition of coatings. It is, moreover, possible to vary and control the composition of the coating material directly during deposition through the use of powder with larger grains. This process appears to be particularly suitable for producing metallic glasses from refractive alloys. Figures 2; references 7: 2 Russian, 5 Western. [50-2415]

UDC 669:539.2/3

MASSIVE METALLIC GLASSES

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 6, Nov-Dec 83 (manuscript received 25 Aug 82) pp 204-206

SHMYREVA, T. P. and VOROB'YEV, G. M., Dnepropetrovsk

[Abstract] Metallic glasses have special physical and technical properties that make them particularly useful for coatings and other applications, but their thin, amorphous nature has limited such use. Continuing studies of gas detonations to deposit such coatings, the authors investigated contact of molten metal, shock wave effects and chemical activity of a crystalline alloy $Fe-P_{18}-C_5$. The transition from crystalline to amorphous state was accompanied by a sharp increase in gas saturation level. After annealing at 770°K and polishing, the alloy was subjected to a 10% sulfuric acid solution for 5 days, resulting in a porous, cracked coating. Electrochemical tests by potentiodynamic curve methodology showed the amorphous coating to have greater corrosion resistance than the crystalline Fe-P-C coating with the same 2-mm thickness. Hardness was greater for crystalline coatings; further processing yielded mixed coatings with the best features of both crystalline and amorphous variants. Figures 2; references 8: all Russian.
[60-12131]

UDC 621.793.6

DIFFUSION METALLIZATION OF MATERIALS USING SHOCK WAVES

Moscow ZASHCHITA METALLOV in Russian Vol 20, No 1, Jan 84 (manuscript received 27 Jan 83, after revision 8 Apr 83) pp 161-163

BEKRENEV, A. N., Kuybyshev Polytechnic Institute

[Abstract] Shock wave processing of alloys is accompanied by various side effects including separation of carbon in martensite and alloying at the contact between varying layers. The present article reports on metallization of nickel, titanium and VT9 titanium alloy using detonations after first annealing nickel at 720°K for 3 hours, and titanium at 1020°K for 2 hours. Results showed that the distribution of copper atoms in the diffusion zone of nickel and titanium samples depended on the pressure generated in shock wave processing. Maximum diffusion mobility was 10 GPa for nickel, 9 GPa for the VT9 alloy and 20 GPa for titanium. Pressure up to 30 GPa brought increased depth of microhardness. The two-metal coatings developed also protected the base alloy from erosion. Figures 2; references 4: all Russian.
[57-12131]

UDC: 620.1-539.4

INELASTICITY OF FIBROUS COMPOSITE MATERIAL AND ITS EFFECT ON FORMATION OF STRENGTH PROPERTIES UNDER STATIC LOADS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 26 Jan 81) pp 100-109

SHORSHOROV, M. Kh., GUR'YEV, A. V., AREF'YEV, B. A., NOSKO, I. N. and BADUNTS, V. Ya., Moscow

[Abstract] It is assumed in this mathematical analysis of fiber-reinforced composite materials that until the moment of failure of the composite the fibers are deformed elastically. Conditions of deformation through the volume of the matrix are essentially heterogeneous, a result of the structural heterogeneity and the heterogeneity of the stress state. As stresses approach the ultimate strength of the composite, conditions are created for merging of separate foci of microplastic deformation developing in the soft matrix into a common larger zone, leading to a qualitatively different state and significantly facilitating relaxation processes upon loading. In the experimental portion of the work, flat specimens made of an aluminum-boron composite by hard rolling were tested in axial extension. As a result, a new structurally sensitive parameter, the "microplasticity modulus," is introduced, allowing estimation of the tendency of a composite material toward the development of inelastic (microplastic) deformation. Analysis of the shape of the extension curves of the aluminum-boron composite shows that upon repeated loading of specimens the intensity of plastic deformation of the soft matrix can be assumed constant, the change in the value of modulus of normal elasticity linear, the extension curve parabolic. Even under very high stresses a portion of the soft matrix may remain free of plastic deformation, helping to increase the resistance of the composite to the development of inelastic deformations. Figures 4; references 19: all Russian.
[42-6508]

UDC: 069-494:539.319

RESIDUAL STRESS IN FIBROUS COMPOSITES LOADED BY LONGITUDINAL FORCE DURING THERMAL CYCLING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 27 May 83) pp 96-99

YEREMENKO, V. I., Moscow

[Abstract] A study is made of the influence of longitudinal load, volumetric content of fibers and rate of change of temperature on internal stresses in fiber-containing heat-resistant composites in the process of thermal cycling. Studies were performed by numerical modeling on a digital computer. The calculation model is one of a heat resistant composite in the form of a cylindrical specimen reinforced with longitudinal continuous tungsten fibers 300-500 μm in diameter. It was assumed that 10-μm-thick nickel-based coatings were applied to the fiber and that the physical-mechanical properties of the coatings did not significantly differ from those of the matrix. The coating prevents the formation of transition layers at the fiber-matrix boundary. The calculations were used to determine the variation of δ of the matrix as a function of volumetric fractions of fibers in the steady stage of thermal cycling. Changes in thermal cycling rate, volumetric fraction of fiber and external load applied cause only slight (not over 10%) changes in the stress in the matrix. Changes of external stress and thermal cycling weight have practically no influence on the stress fields of the matrix in this stage, assuming constant fiber content. Figures 3; references 2: both Russian. [42-6508]

UDC: 539.216.1

STRENGTH OF Nb_3Sn INTERMETALLIDE LAYER IN BRONZE/NIOBIUM FIBER COMPOSITE MATERIAL

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 273, No 2, Nov 83 (manuscript received 19 Apr 83) pp 336-339

SAVITSKIY, Ye. M. corresponding member, USSR Academy of Sciences, YEFIMOV, Yu. V., USTINOV, L. M., FROLOVA, T. M., VINOGRADOV, L. V., and ZHAMNOVA, V. I., Institute of Metallurgy imeni A. A. Baikov, USSR Academy of Sciences, Moscow

[Abstract] The strength of the Nb_3Sn layer in a superconducting bronze/niobium fiber composite material is quite important, since it largely determines the stability of the superconducting properties. An experiment was performed to estimate the strength of this layer. Square cross section strips 40 mm in length and 8x8 mm in cross section were annealed at 750°C in a vacuum for 16, 48, 120 and 240 hours, forming an intermetallide Nb_3Sn 21 μm thick at the fiber/matrix division boundary. Specimens were cut so as to expose the niobium fibers on one surface over the entire gage length. This

surface was polished with diamond paste and the specimens were tensile tested at 0.1 mm/min, room temperature in a special scanning electron microscope attachment. The relative elongation at which the first cracks appeared was found to be unusually high. One possible cause of the high value may be residual compressive stresses arising upon cooling of the composite material from the annealing temperature to room temperature. It is concluded that the intermetallide layer was in a state of elastic-plastic deformation upon extension of the composite material. As the thickness of the layer increases its strength decreases. References 6: 4 Russian, 2 Western.
[32-6508]

UDC: 539.4:678.067

STUDY OF INFLUENCE OF LONGITUDINAL-TRANSVERSE REINFORCEMENT STRUCTURE ON ORGANOPLASTIC STRENGTH IN PLANAR STRESS STATE

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 31 Mar 83) pp 805-810

KULIK, V. I., MESHKOV, Ye. V., NILOV, A. S. and UPITIS, Z. T., Leningrad Institute of Mechanics; Institute of Polymer Mechanics, Latvian Academy of Sciences, Riga

[Abstract] One method of studying the properties of layered composite materials is based on a phenomenologic approach, in which the heterogeneous material is looked upon as a continuous medium, the mathematical model of which is based on experimental data. This approach suggests the description of the strength of the composite material by means of failure criteria determined by the shape and size of a certain limiting surface in the stress space. The goal of the method is determination of the component of the tensor-polynomial fracture criterion from the experimental data. The task of approximation is reduced to processing of experimental data in such a manner that the summary quadratic deviation of the strength surface from the experimental strength values is minimal. Experiments were performed on thinwall tubular specimens with a gage section length of 70 mm, inside diameter 68 mm and longitudinal-transverse reinforcement with various ratios of transverse layer thickness to longitudinal layer thickness. The results obtained can be used to predict the strength of organoplastic materials of this type. A significant mutual influence of σ_{11} and σ_{22} on the strength of the material was determined manifested as a decrease in strength of biaxial extension and nonlinear nature of the variation of the optimal ratio of thickness of transverse layers to that of longitudinal layers as a function of the ratio of σ_{22} to σ_{11}. Figures 4; references 4: all Russian.
[30-6508]

UDC: 678:541.347

STRUCTURAL SPECIFICS OF POLYMER HYBRID MATRICES RESULTING FROM MICROPHASE SEPARATION MECHANISM

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 5 Apr 83) pp 771-780

LIPATOV, Yu. S., Institute of the Chemistry of High Molecular Compounds, Ukrainian Academy of Sciences, Kiev

[Abstract] Microphase separation in a solidifying grid based on styrene with divinylbenzene and polybutylmethacrylate dissolved in the mixture was studied. A laser diffractometer was used to determine the time of beginning of phase separation in the system as a function of linear polymer content for various temperatures and initiation conditions. It was found that increasing the concentration of PBMA resulted in a significant shortening of the time to beginning of separation of the system into phases. Increasing the temperature at constant PBMA concentration also decreases the time at which phase separation begins. It is concluded that the structural specifics of hybrid binders are such that as a result of microphase separation, thermodynamically unstable systems develop which, due to kinetic factors, remain mechanically stable for an arbitrarily long time. Figures 7; references 22: 16 Russian, 6 Western.
[30-6508]

UDC: 539.4:678.067

ANALYTIC SOLUTION IN PROBLEMS OF OPTIMAL REINFORCEMENT OF LAYERED PLATES OF COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 22 Feb 83) pp 788-793

KARTVELISHVILI, V. M. and KOBELEV, V. V., Institute of Problems of Mechanics, USSR Academy of Sciences, Moscow; Moscow Physico-Technical Institute

[Abstract] A study is made of an elastic anisotropic plate of constant thickness in a rectangular system of coordinates. The plate has a layered fiber structure obtained by regular layup of a number of reinforced layers with periodic structure formed by locally homogeneous layup in an elastic matrix. The effective rigidity tensor of the plate is assumed homogeneous through its thickness. Problems of optimizing the rigidity functional of plates flexed by transverse loading are studied. The problem of optimizing the fiber layup angle in a layered plate in flexure is also analyzed. The method of successive approximation is used to obtain approximate analytic solutions. Figures 3; references 5: all Russian.
[30-6508]

UDC: 539.4.678.067

STABILITY OF DELAMINATION IN COMPOSITES

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep-Oct 83
(manuscript received 22 Feb 83) pp 794-798

PARTSEVSKIY, V. V., Higher Fire Engineering School, USSR Ministry of Internal Affairs, Moscow

[Abstract] A study is made of delamination in multilayer composite structure in the vicinity of cracks transferred to the layers. The composite model studied consists of regular alternating layers of different rigidity. Equations are derived which define the shear and normal stresses between layers up to the delamination. Empirical studies are presented of the solutions of the problems of biaxial tension and tension with shear. The results obtained allow an explanation of the mechanism of the essentially stable nature of delamination in uniaxial extension in the direction of reinforcement. The results indicate a change in mechanism of failure of a composite with transverse cracks with a change in the ratios $\sigma^{\infty}_{33}/\sigma^{\infty}_{13}$ or $\sigma^{\infty}_{13}/\sigma^{\infty}_{11}$. Figures 4; references 11: 6 Russian, 5 Western.
[30-6508]

UDC: 539.4:678.067

REGULARITY OF SHORT-TERM AND LONG-TERM STRENGTH OF COMPOSITES IN COMPLEX STRESS STATES

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep-Oct 83
(manuscript received 5 Mar 83) pp 799-804

MAN'KOVSKIY, V. A., Sevastopol Higher Marine Engineering School

[Abstract] This article is intended to check the applicability of most existing short-term strength criteria for the description of known, representative experiments on nonaxial fracture of composites, to develop a criterion of long-term strength and compare it with existing conditions of failure using known, general long-term experiments and to develop practical recommendations for the application of strength criteria and anisotropy equations describing the change in strength characteristics of composites as a function of angle of placement of the reinforcing elements. Experimental data are described on the failure of multilayer carbon-epoxy composite types used in rocket technology. The method suggested is quite general, since the procedure of dispersion analysis is virtually insensitive to the distribution of mechanical characteristics or durability in the initial equations used, making the equations derived in this article suitable for a broad range of materials regardless of their short-term and long-term fracture characteristics. Figures 2; references 18: 12 Russian, 6 Western.
[30-6508]

UDC: 629.7:678.067

SOUND ABSORBING COMPOSITE STRUCTURE FOR GAS TURBINE ENGINES

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 31 Mar 83) pp 838-843

KUZNETSOV, N. D., VESSELOV, S. I. and KARTASHOV, G. G., Kuybyshev Aviation Institute imeni Academician S. P. Korolev, Kuybyshev

[Abstract] Metal sound-absorbing structures are used in gas turbine engines, but all have significant shortcomings. The need has therefore arisen to develop materials capable of meeting the various requirements placed on sound-absorbing structures for such engines. These demands are described and results are presented from comparison of the effectiveness of FRP and titanium alloys. The fiberglass-reinforced plastic is found to be superior to titanium in terms of vibration endurance, specific flexural rigidity and shear strength. Composite materials are also technologically superior to titanium alloys. Diagrams illustrate the failure of composite material sound-absorbing structures. The results of the studies indicate means for further improvement of composite sound-absorbing structures with glass fabric honeycomb design, including an increase in fatigue strength in transverse shear and joint work of panels and shells. The quality of bonding between titanium and the honeycomb filler must be improved, possibly by introducing glass fabric between the honeycomb and the titanium layer. Figures 6; references 4: all Russian.
[30-6508]

UDC 678.01:539.4

NEW MECHANISMS OF POLYMER MATRIX FRACTURE

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 21 Mar 83) pp 980-982

PETROSYAN, M. K., KUZNETSOVA, I. G. and KOVRIGA, V. V., Plastics Scientific Research Institute of the "Plastmass" Scientific Production Association, Moscow; "Norplast" Scientific Production Association, Moscow

[Abstract] Construction thermal plastics frequently suffer premature fractures that end their useful life. The authors studied the connection between the maximum deformation limit of terephthalate and the various forms of surface fractures, as well as the transition from one form to another as deformation increases. A typical feature of surface failure was a ring-like zone with smooth and rough zones, affirming the multi-phase surface of fractures. Increased temperature and consequently increased deformation caused more pronounced craters over a broader expanse, as the next phase of fracturing. As deformation grew, the number of craters declined but the space they covered increased. Figures 5; references 3: all Russian.
[59-12131]

UDC 539.375:678.01

RELAXATIONAL PROPERTIES OF HEAT-RESISTANT CONSTRUCTION POLYMERS IN BROAD TEMPERATURE RANGE

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 22 Mar 83) pp 983-988

BANYAVICHYUS, R. B., AMBRAZYAVICHYUS, A. V., MIGONENE, Z. B., BARAUSKAS, A.I. and MARMA, A. I., Kaunas Polytechnical Institute imeni A. Snechkus; Kaunas Machinebuilding Production Association imeni F. E. Dzerzhinskiy; Vilnius Plastics Plant

[Abstract] Heat-resistant polymers that soften at 200-400°C with a wide temperature range of glass-like states and low temperatures of brittleness were studied in isothermal conditions of creep and relaxation at low and high temperatures. Materials tested included polybenzoxazole, polyoxadiazole and several polyimides. Temperatures ranged from -150°C to the glass point of the respective polymers, and degrees of deformation and tension ranged from minimal values to a loss of linearity in viscous-elastic behavior. Through the entire temperature range, increased deformation was accompanied by increased internal tension. Three sub-zones with varying relaxational processes are discussed as typical for all tested polymers. As tension increased at a given temperature, creep curves shifted in the direction of greater deformation. In general, the tests showed that the materials could be used effectively in a wide range of temperatures without failure. Figures 5; references 16: 15 Russian, 1 Western.
[59-12131]

UDC 539.4:678.067

PREDICTING FATIGUE DURABILITY OF POLYMER AND COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 2 Mar 83) pp 1010-1015

BAREISHIS, Y. P., SINICKAS, G. S. and STIRBIS, A. P., Kaunas Polytechnical Institute imeni A. Snechkus

[Abstract] An important problem in assessing fatigue is in calculating durability on the basis of design, technological and use factors. The authors sought to establish an approach for weighting cyclical deformation factors such as frequency and magnitude of loads and environmental temperature as part of a family of influences affecting construction materials. The test material was a heat-hardened plexiglass reinforced with polymer fibers. The module of elasticity was chosen as the parameter reflecting failure most precisely. Experimental data suggested a strong, nearly functional correlation between the modified variables (temperature, load and frequency of oscillations). Frequency was of the least importance in predicting failure of the tested materials. The function $\underline{P}_i$-lg$\underline{N}_p$ relates the module of elasticity and the cyclic variable. Figures 4; references 8: all Russian.
[59-12131]

UDC 624.074:678.067

DURABILITY OF SHELL CONSTRUCTIONS FROM COMPOSITES PRODUCED BY WINDING

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 83
(manuscript received 18 May 83) pp 1034-1043

PROTASOV, V. D. and YERMOLENKO, A. F.

[Abstract] Wide use of laminated polymers in modern technology is governed by their mechanical, thermal and electrophysical properties and means to control them to obtain durable products. Differeing structural and phenomenological approaches are used for such calculations, and these are divided into statistical and deterministic aspects. The authors use a statistical structural approach to determine the failure processes in test laminated shells with numerous elements of varying mechanical properties. Calculations and a diagram illustrate the method. Other areas calculated include shell durability with uneven load, evaluation of individual bearing capacity of various shells and optimal design planning for laminated shells. The proposed method makes it possible to select sufficiently durable materials without needlessly using scarce or expensive alternatives. Problems that remain include the need for high-speed computers to make the necessary calculations and the scattered statistical patterns shown by some composite materials. Two stages for data processing, a deterministic statement of the problem followed by consideration of statistical dispersion of characteristics, are recommended for assessing shell durability. Figures 5; references 9: all Russian.
[59-12131]

UDC 624.074:678.067

STRESS STATE AND ENERGY CAPACITY OF ROTATING SHELLS OF COMPOSITES WOUND ALONG GEODESIC TRACKS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 83
(manuscript received 19 May 83) pp 1044-1056

POLYAKOV, V. A., PORTNOV, G. G. and MOORLAT, P. A., Institute of Polymer Mechanics, LaSSR Academy of Sciences, Riga

[Abstract] The present article considers meridians of hollow shells with peripheral rims to determine their energy collecting capacity. Calculations for a constantly revolving laminated shell wound along a given track are presented and discussed. The advantages of fluid linking as the most advanced technology for laminated generator shells are summarized. Further data are given for stress state, kinetic energy, and comparative energy capacity of geodesic and distributed-stress shells with smooth linking at the polar opening and the "equator" and for equivalent geometric parameters. Results demonstrate that the energy capacity of hollow geodesic shells is insufficient to warrant their use. Other theoretical limitations support the preference for balanced-stress shells and thin rings. Figures 8; references 4: all Russian.
[59-12131]

UDC: 669-494

ESTIMATING CRITICAL LENGTH OF REINFORCING FIBERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 3 May 82) pp 141-143

SHORSHOROV, M. Kh., USTINOV, L. M., and VERKHOVSKIY, L. A., Moscow

[Abstract] A study is made of the capabilities of both traditional and new equations for estimating the critical length of reinforcing fibers. To test the equations, a production run of boron fibers about 100 μm in diameter was used to manufacture specimens for tensile testing at 2 mm/min. It is found that as the gage length of the boron fibers decreases from 1000 to 5 mm, mean strength increases from 3340 to 4100 MPa, while coefficient β remains almost constant until gage length becomes quite short. Both traditional and new equations are found to be suitable for estimation of the critical length of metal reinforcing fibers. Figures 2; references 5: 3 Russian, 2 Western. [42-6508]

UDC 678.2:539.385:678.067

STRUCTURAL INSTABILITY OF REINFORCED FIBERS IN PROCESSING COMPOSITE MATERIALS BY WINDING METHODS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 30 Mar 83) pp 1057-1063

TOMASHEVSKIY, V. T. and YAKOVLEV, V. S. Naval Academy imeni Marshal of the Soviet Union A. A. Grechko, Leningrad

[Abstract] Structural instability, or the capacity of a reinforced fiber to bend in a polymer matrix, can occur by bending the fiber in the hardened matrix under the impact of external compressing loads, or during technical processing. Although such instability can profoundly affect durability and brittleness, little study has been devoted to it. The authors report on studies of temperature and time functions in a closed ring of reinforced fibers to determine critical parameters of structural instability. Other factors were regarded as constants for the study. Data analysis indicates that the most likely form of this instability is cophasal, since that form corresponds most closely to the least critical load magnitude. Conversion processes in the polymer matrix result in 2-3 times the values for critical parameters in the reinforced fibers. Experimental data (not given) correspond satisfactorily to the theoretical data. Figures 4; references 5: all Russian. [59-12131]

UDC 620.193.4

EFFECT OF COPPER ON CORROSION OF SOLDERED VT23 ALLOYS IN 3% NaCl SOLUTION

Moscow ZASHCHITA METALLOV in Russian Vol 20, No 1, Jan-Feb 84
(manuscript received 22 Nov 82, after revision 11 Feb 83) pp 49-53

YERCHENKO, N. S., RYL'NIKOV, V. S., MAKORDEY, F. V., SHPIGEL', A. S., MALYUTA, L. P., KALYUZHNAYA, Ye. A., KRAYEVSKAYA, Ye. M. and ULANOVSKAYA, L.I., Odessa State University

[Abstract] Silver solders commonly used to join titanium parts suffer greatly from corrosion when used in tropical and seaside locations. The present article reports on new solders combining 2-8% copper with the silver, and pure silver solders, used to join commercial VT23 titanium alloy (1% Cr, 0.6% Fe, 2% Mo, 4.5% W, and 4.5% Al). After soldering in an argon atmosphere at ca. 930°C for either 5 or 60 minutes, the articles were polished and degreased with 50% acetone, 50% methyl alcohol with or without 0.5% citric acid or benzene. Etching with 2g HNO_3 + 2g HF + 96g H_2O, fractographic and atom-absorption spectrometry showed the structure and properties of the soldered joint zones. Structures included intermetallide compounds, diffusion of silver solder along granule boundaries and solid variable silver solutions in the titanium alloy. The 60-minute soldering temperature enhanced corrosion resistance. With pure silver solder, the entire soldered surface suffered corrosion damage. Addition of 2-5% copper with 5 minutes at soldering temperature increased corrosio.. resistance, so that only 30% of the surface was damaged. The broader seams obtained in the 60-minute variant suffered corrosion damage over the area of the broad seam. Best results were found with minimum seam width (2-4 mkm) and 2-5% copper in the solder, and heating time of 60 minutes. Figures 4.
[57-12131]

UDC 620.194

CERTAIN UNRESOLVED PROBLEMS OF ELECTROCHEMISTRY OF CORROSION CRACKING

Moscow ZASHCHITA METALLOV in Russian Vol 20, No 1, Jan-Feb 84
(manuscript received 2 Jun 82) pp 77-84

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[Abstract] Electrochemical properties of the metal-electrolyte system are the keys to corrosion cracking in most construction materials, and the pitting process is often the most important. The present article reports on the growth of cracks as zones for concentrated tension and limited electrolyte exchange. High mechanical tension at fracture surfaces and localized electrochemical processes on granules smaller than the fracture size itself are discussed as important factors in cracking failure. Hydrogen emission causing growing brittleness is another key process. The crack surface serves as an anode relative to its walls and ionization of metals takes place, while cathode processes of hydrogen adsorption and absorption are localized on crack walls and the article's surface. Study of hydrogen emission as the central factor requires elimination of other corrosive factors and monitoring of crack development rate due to hydrogen emission in comparison with other factors. Electrochemical polarization and the need for close study of macro- and micro-levels of corrosion cracking are also discussed. References 49: 15 Russian, 34 Western.
[57-12131]

UDC 620.191.33:620.194.8

CONDITIONS AT CRACK TIP DURING TESTING OF MATERIALS IN CORROSIVE MEDIUM

Moscow ZASHCHITA METALLOV in Russian Vol 2, No 1, Jan 84
(manuscript received 6 Dec 82, after revision 9 Mar 83) pp 85-90

RATYCH, L. V., DMYTRAKH, I. N., PUSYAK, S. A., KUROV, O. V., Physicomechanical Institute imeni G. V. Karpenko, UkSSR Academy of Sciences

[Abstract] Previous study of cracking processes have not considered the relationship between crack tip features and tension and deformation states at the surface of the article. The proposed method includes determination of pH and electrode potential at crack tip and presents data for given tension and deformational states in the vicinity of the crack in dependence on medium, crack length, external polarization potential and the number of load cycles in samples of 40Ch13 steel in a pH 8 aqueous solution. The tested 10x20x150-mm sample had fatigue precracking with an opening for adding an electrolyte capillary. The device for electrochemical testing is diagrammed and described. Results indicated that deviation of pH and electrode potential of the metal at the crack tip from the same parameters on the sample surface depended on the duration of medium action, crack length and external polarization potential, while in the developing crack, the length of testing and the coefficient of

tension intensity were also involved. Minimum pH value at the crack tip of a stationary, statically loaded crack equalled 2.3, while in a developing cyclically loaded crack it was -0.4. Figures 5; references 12: 8 Russian, 4 Western.
[57-12131]

UDC 541.138.2

KINETICS OF ANODE DISSOLUTION AND ACTIVE-PASSIVE TRANSFORMATION OF TITANIUM IN NARROW CREVICES

Moscow ZASHCHITA METALLOV in Russian Vol 20, No 1, Jan 84
(manuscript received 2 Nov 82) pp 120-124

MASLOV, V. V., SUKHOTIN, A. M. and REYNGEVERTS, M. D., Leningrad Polytechnic Institute imeni M. I. Kalinin

[Abstract] Study of spatial distribution of the corrosion process in narrow metallic crevices filled with electrolyte has both theoretical and practical importance. The present article reports on experimental testing of earlier equations describing polarization and flow in a narrow crevice. VT1-0 titanium alloy was subjected to a 20% HCl solution with 0.762 $Om^{-1}cm^{-1}$ electrical conductivity. The coated cylinders were fixed in place and corrosive solution and electrical charge directed to concentrate on the cylindrical crevice being tested. With the aid of a supplemental ring-shaped platinum electrode, voltampere anode features were recorded. Tests were conducted at room temperature. Results of the experiments agreed both quantitatively and qualitatively with theoretical results. Processes taking place in anode solution crevices also occurred in cracks that developed under corrosive conditions under tension, and as cracks in passive metal deepened, corrosion cracking became more active and persistent on the metal surface. Figures 3, references 5: 4 Russian, 1 Western.
[57-12131]

GENERALIZED APPROACH TO VAPORIZATION OF MATERIALS BY HIGH-POWER ENERGY FLUXES

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 19 Jan 82) pp 34-37

KAZAKOV, G. M., KAZAKOVA, N. A. and SHMAKOV, G. S., Gorkiy

[Abstract] A generalized theoretical approach is taken to vaporization of materials by electroerosion treatment with high-power energy pulses. The mechanism of the process is analyzed on the basis of heat balance and the equation of transient heat conduction from a planar heat source at the electrode tip to the surface of a solid material through a building-up vapor layer. Into acccunt are taken conditions of the electric discharge and back pressure of the plasma jet, assuming constant thermophysical properties of the materials involved. The problem, formulated in a rectangular system of coordinates moving with the evaporation front, is so highly nonlinear as not to be solvable analytically, a numerical solution being encumbered by the large number of variables. Here an attempt is made to simplify the problem and its solution by first putting it in a dimensionless form, with the most appropriate characteristic length, temperature, thermal flux density, and pressure as scales for these four quantities, and then using the Dulong-Petit law to describe intense evaporation which for all materials occurs far above the Debye temperature. A solution of the thus simplified problem for the appropriate initial and boundary conditions yields first the evaporation transient and then the steady-state temperature field. On this basis, with numerical values of parameters characterizing specific electrode materials (copper, aluminum oxide) and treated materials, it is possible to optimize the electroerosion process. This method of analysis is particularly helpful in the case of heterogeneous treated materials consisting of two or more components. The effective properties of such a material are the volume-weighted averages of the corresponding properties of its components. Figures 2; references 5: all Russian.
[50-2415]

UDC 536.46:546.3

USE OF LASER RADIATION TO PRODUCE A THIN AMORPHOUS METAL LAYER

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 30 Mar 82) pp 53-58

GLYTENKO, A. L., KUDINOV, G. M. and SHMAKOV, V. A., Podol'sk

[Abstract] This work presents a theoretical study of the process of amorphization of a thin surface layer of metal under the influence of pulse laser radiation. The mathematical analysis is based on the assumption that the power of the incident radiation flux is such that a solid two liquid phase conversion occurs. Equations are presented for the temperature fields in the liquid and solid phases and the boundary conditions of the problem. Solving the equations allows computation of the cooling rate and characteristic dimensions of seeds formed as the melted layer solidifies. Typical cooling rates are as great as 10^9°C/s, generating a seed diameter on the order of the interatomic distance of $3 \cdot 10^{-8}$ cm. The metal liquid is thus frozen, forming a metastable amorphous state. If a longer laser pulse is used (10^{-6} s) a polycrystalline layer structure is obtained. References 10: 9 Russian, 1 Western. [42-6508]

UDC: 669.71:539.56:539.1.043

RADIATION DAMAGE IN BINARY ALUMINUM-BASED ALLOYS UPON NEUTRON BOMBARDMENT

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 3 Mar 83) pp 3-7

IVANOV, L. I., KALININ, V. G., PLATOV, Yu. M., PLETNEV, M. N., SMIRNOV, A. V., TOVTIN, V. I. and SHAMARDIN, V. K., Moscow

[Abstract] Results are presented from a study of the specifics of radiation damage to binary alloys of aluminum with magnesium and zinc, which are typical alloy or impurity elements in industrial aluminum alloys. Specimens of Al, Al+0.11 at.% Mg, Al+50 at.% Mg, Al+2.2 at.% Mg and Al+0.02 at.% Zn were annealed in air at 550°C. The disk-shaped specimens 12 mm in diameter and 0.45 mm thick were bombarded at 100±25°C with a dose of neutrons with E>0.1 MeV of $2.6 \cdot 10^{24}$ n/m^2, thermal neutrons $1.7 \cdot 10^{25}$ n/m^2. The specimens were then electrolytically polished to remove the oxide film. Some of the specimens were then annealed at 450°C. Microhardness was measured and gamma quantum annihilation angular correlation spectra measured. It was found that Mg atoms increased the total concentration of dislocation loops and cores in irradiated Al-Mg alloys. Where the Mg concentration is 0.5 at.% or higher, saturation develops and the characteristics of positron annihilation and radiation hardening do not further increase with increasing Mg content. Unsaturated Al-Zn solid solutions are greatly hardened by neutron bombardment, which may result in the formation of radiation-stimulated segregations. Segregation of Zn atoms at dislocation-type defects is suggested as a possible mechanism. Figures 4; references 12: 4 Russian, 8 Western.
[42-6508]

UDC: 539.12.04:621.039.616

RADIATION EROSION OF CARBON-GRAPHITE MATERIALS AND SiC

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 20 Jul 81) pp 8-12

BOBKOV, Yu. V., KALIN, B. A., KARTSEV, P. I., SKOROV, D. M. and SOKURSKIY, Yu. N., Moscow

[Abstract] A comparative study is presented of the nature of surface erosion of certain carbon-graphite and silica carbide materials with low values of Z upon bombardment by helium ions. Small- and large-grained SiC and nuclear and ARB graphite and vitreous graphite were studied. Specimens were prepared by the usual method including diamond paste polishing and degreasing in acetone and alcohol. Bombardment was performed in a mass monochromator by He^+ ions with an energy of 20 KeV, current density 660 μA, at temperatures of 333 and 923°K to a dose of $5 \cdot 10^{22}$ ions per square meter in a vacuum of $1.33 \cdot 10^{-4}$ Pa. The topography of the irradiated surface was studied with a scanning electron microscope. Erosion of both types of SiC occurred by atomization and blistering, with at least two generations of blisters formed at both low and high temperatures. Erosion of graphites at low temperatures depended on the method of production and was defined by physical atomization, whereas at high temperatures both atomization and delamination of the covers of gas-filled cavities occurred. Erosion of vitreous graphite of low temperature was practically not observed; at 923°K some slight physical atomization of the surface occurred. Figures 5; references 14: 5 Russian, 9 Western. [42-6508]

POWDER METALLURGY

BARRIERS TO THE INTRODUCTION OF POWDER METALLURGY

Moscow EKONOMICHESKAYA GAZETA in Russian No 3, Jan 84 p 9

[Article by G. Rykov, head of Minelektrotekhprom's New Materials Adoption Department; Ya. Gluskin, head of the powder metallurgy sector of the VNII [All-Union Scientific Research Institute] of Electrical Carbon Products: "Problems Await Resolution"]

[Text] What hinders the wide use of progressive technology?

According to experts, it is the quality of raw materials and equipment and the wholesale price.

The advantages of powder metallurgy are well known. It is estimated that the production of every thousand tons of general machine-building articles by this method adds about 1.5 million rubles to the economy, frees 190 workers and 80 lathes, and saves 2,500 tons of rolled ferrous and non-ferrous metals. But these are not all the advantages. Powders make it possible to control porosity and structure, bond various metals and nonmetals into composites, and to produce materials with unique mechanical, electrical and magnetic properties which cannot be done on an industrial scale using other methods of production, in other words, to construct new materials with pre-assigned properties. It is no accident that one of the most important scientific-technical programs is devoted to dissemination of this technology.

For nearly half a century the electrical engineering industry has been involved with the adoption and development of powder metallurgy. The [electrical engineering] branch is one of the largest producers and users of articles sintered from powders. It has accumulated solid know-how. Clearly visible in its background however, are problems hindering active utilization of the highly effective technology on a significantly wider scale than previously.

Minelektrotekhprom enterprises obtain metallic powders for the production of articles from ferrous and non-ferrous metallurgy. There is a sufficient amount of raw materials. Machinebuilders are earnestly concerned with their quality.

Very often the available powders are obtained by electrolysis. Each of their grains seen under a microscope suggests the structure of a spruce twig--it

has the so-called dendrite structure. This has a negative effect on the powders' fluidity: they do not completely fill the volume of the compression mold. This gives rise to a defect due to incomplete molding. Annual output is very low. The advantages of the progressive technology are therefore lost.

Unfortunately, GOST [All-Union State Standard] allows such "clearance" for electrolytically produced powders, that the plants producing the articles must have several compression molds for each part produced from one brand of raw material. Just as a meal should not be prepared from poor-quality products, so a good article should not be made without the requisite material. One would think it is time Gosstandart clarified its requirements for the characteristics of electrolytic powders.

The example of one of our most conscientious suppliers, the Tulachermet Association, emphasizes that it is possible to produce powders of the highest quality. Tula's stainless steel compounds are used successfully in the production of hard-metal high-speed tools, drilling technology and in a number of other fields. They contribute significantly to the conservation of expensive molybdenum, tungsten, cobalt, vanadium and chrome, and the strength of the tools doubles or triples.

But such a supplier, alas, is rare. Another of USSR Minchermet's enterprises, the Krasnouslinskiy Metallurgical Plant, constantly lets us down. Some of USSR Mintsvetmet's enterprises are still poorly managing the development of "fluid" powders, obtained by spraying molten metal. In the 11th Five-Year Plan the electrical engineering industry requires about 1,000 tons of this raw material. However, both of our suppliers, the Baku Experimental Plant of Powder Metallurgy and the Alaverdi Mining and Smelting Combine, are still not ready for this.

A semi-commercial installation operating at the Baku plant was recommended by the Institute of Problems of Material Science of the UkSSR Academy of Sciences. Atomized brass and bronze powders produced on it do not meet the requirements of the electrical engineering industry due to their granulometric and chemical compounds, bulk density, compactability and presence of impurities. It is essential to "ready" the installation as rapidly as possible, because the plant has produced many tons of defective products. Recently the Baku air conditioner plant telegraphed our ministry that an entire batch (5 tons!) of bronze powder sent by villagers had again been scrapped.

Things are no better at the Alaverdi combine. We received the first experimental batch of three tons about three years ago. Of this amount about 50 kg of production-quality powder was successfully sifted, but with great difficulty. Over the past three years we have accumulated three thick folders of correspondence with this enterprise, but this has had practically no effect on the quality of raw material.

When the Price Is No Incentive

Quite often electrical enterprises are literally stuck with brands of raw material which the producer has on hand, not the required brands. Although even higher quality powders are offered, in the given case, this does not please the customer. These are expensive. It is also uneconomical not to use expensive material for its intended purpose.

For example, one of the nation's oldest enterprises of powder metallurgy, the Kineshma Elektrokontakt Plant, with the authority of the USSR Gossnab, produces magnetic circuits with pure iron powders costing 2,000-2,600 rubles a ton instead of PZh2M powder, which costs a little over 1,100 rubles a ton. As it happens, the parts produced by progressive technology are artificially placed in an economically unprofitable position compared with those made from rolled products. Customers avoid them, in spite of their higher performance characteristics.

The problem is not only the absence of needed brands of raw material. The very prices for metallic powders discourage wide introduction of progressive technology in domestic machinebuilding. On the average, these prices are 1.5-2 times higher than those of rolled products. Why? To be sure powder is much lighter in production and requires less energy and labor consumption. When it is obtained, there is no need for expensive, energy-consuming stand rolling of blanks, repeated heating and cooling operations and many others. Generally speaking, the entire process boils down to spraying a stream of molten metal with gas or water, then drying it and separating the particles by size in the sieves.

However, the iron-based powder used most frequently in production of construction parts, brand PZh3M, is priced at 462 rubles a ton, but is worth about half as much. At the same time, the price of even especially complex rolled ferrous metals is in the range of 130-180 rubles a ton.

We would like to turn the attention of the USSR Goskomtsen [State Committee on Prices] to the obvious disparity in prices of powders for the tasks of scientific-technical progress.

Finally, the third problem, on whose solution the development of powder metallurgy greatly depends, is the reliability of presses supplied by the Minstankoprom enterprises. The acuteness of the situation may be seen in the example of the Riga experimental plant for producing articles of powder metallurgy.

Having come on stream at the end of 1982, it was fitted with the most superior and progressive domestic equipment. However, its production quality leaves much to be desired. Ten of the presses do not at all meet the conditions of serial production. There were cases when aggregates had to be removed and returned to the producing plant for repair--so serious were the defects.

For this reason the Riga plant produced almost 900 tons of articles less in 1982 and 2,000 tons less in 1983 than it was supposed to. As a result, the electrical engineering industry was forced during this time to over-consume 8,500 tons of copper and steel rolled products. The Riga workers' correspondence proved fruitless. So the presses were not brought up to quality.

The problems we have discussed are completely solvable. Powder metallurgy should occupy a worthy place among the most popular technologies.

12421
CSO: 1842/76

UDC 621.762

PRODUCING HIGH-SPEED TOOL STEELS BY PULVERIZATION WITH WATER

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 83
(manuscript received 15 Apr 83) pp 1-3

SANIN, A. F., KARPINOS, D. M., KALINICHENKO, V. I. and DOMORATSKIY, V. A., Dnepropetrovsk State University; Institute of Problems in Materials Science, UkSSR Academy of Sciences

[Abstract] High-speed tool steels in powder form are produced by pulverization of the melt, water having been found to be a better pulverizing agent than an inert gas. In a study made of this process and its product, R6M5 and R6M5K5 steels were produced by smelting in an open induction furnace and subsequent pulverization with water under a pressure of 15.2 MPa in a nitrogen atmosphere at a temperature not more than 50° below the furnace temperature. The powder was first water cooled, then dehydrated and vacuum dried. The powder particles had a fine-disperse cellular-dendritic microstructure forming nonspherical grains with a mean dimension of 71 μm (R6M6) or 74 μm (R6M5K5) and a maximum dimension of 540 μm, deviations from the mean dimension being much smaller than in the case of powder produced with nitrogen. The principal phase components of such powder are found to be martensite and austenite, with only some δ-ferrite which has not transformed to austenite during fast cooling. The -250+200 μm fraction was used for producing ingots and examination of their properties, the density of powder increasing from 3.05 g/cm^3 in the loose state to 8.22 g/cm^3 in the compact state. The high hardness of ingots must be reduced along with the oxygen content, to facilitate further processing of the steel, most effective being two-step vacuum annealing at 900-1100°C. An oxygen content as low as 0.16% is attainable, still lower in finer fractions. Subsequent heat treatment will fully restore the protective oxide film on the surface of powder particles. Figures 2; references 4: 3 Russian, 1 Western.
[50A-2415]

UDC 621.762:669.295.24

PRODUCTION OF TITANIUM NICKELIDE BY SINTERING COMPACT MIXTURES OF NICKEL AND TITANIUM POWDERS WITH INTERDIFFUSION OF COMPONENTS WITHOUT FORMATION OF LIQUID PHASE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 83
(manuscript received 12 Apr 82) pp 40-46

AKSENOV, G. I., DROZDOV, I. A., CHERNOV, D. B., UVAROV, A. A. and ATYAKSHEV, Yu. A., Kuybyshev Aviation Institute

[Abstract] The feasibility of producing porous titanium nickelide with "shape memory" by solid-phase sintering (without liquid phase) of compact equiatomic mixtures of interdiffusing nickel and titanium powders was established in an earlier study (POROSHKOVAYA METALLURGIYA No 5, 1981). In a subsequent study attempts were made to increase the mechanical strength of this product, and also to improve its other mechanical properties. Mixtures of PTM titanium powder and PNK-1 carbonyl nickel powder or PNE-1 electrolytic nickel powder were molded under a pressure of 900 MPa into prismatic, cylindrical, and annular specimens with 19-23% porosity. These specimens, with a residual pressure of $6.65 \cdot 10^{-3}$ Pa, were then heated in a muffle furnace and held for 2 hours at 800°C. One control batch was then cooled down for testing. Four other batches were vacuum sintered for 2 hours at 950, 1000, 1100, and 1200°C respectively, before being cooled down for testing. Tests included microstructural examination, phase constitution analysis, electrical conductivity measurement, and measurement of mechanical properties (deformability, plasticity) as well as their dependence on the sintering temperature, also flexural loading with temperature cycling (heating to 200°C + cooling to -196°C). The results of thermomechanical and electrical tests were evaluated and interpreted in accordance with standard relations in the theory of porous media and indicate that the reversible thermoelastic strain in specimens sintered at any temperature increases monotonically as the applied stress increases up to 200 MPa. The maximum thermoelasticity (up to 3%) is ensure by sintering at 1000-1100°C, only specimens sintered at 1100-1200°C being able to withstand a stress of 200 MPa. The results also indicate that better physicomechanical properties of porous TiNi are obtained with carbonyl nickel powder than with electrolytic nickel powder. Figures 4; references 6: all Russian.
[50A-2415]

UDC: 621.762

STRUCTURE AND THERMAL EXPANSION OF COMPLEX NbC-Based Carbides

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 83
(manuscript received 3 May 82) pp 94-99

KHATSINSKAYA, I. M., CHAPOROVA, I. N., CHEBURAYEVA, R. F., SAMOYLOV, A. I., LOGUNOV, A. V., IGNATOVA, I. A. and DODONOVA, L. P., Moscow

[Abstract] A study is presented of the structure, phase composition, density, microhardness and thermal expansion of NbC alloyed with group IV-V transition metals. Studies were performed by mathematical planning with a full factor 2^4 experimental matrix with the independent variable factors (mass share of element) 1-5% Mo, 1-3% V, 5-15% Hf, and 4-12% W. The planning parameters considered the actual limits of variation of composition of the carbide phase of the Ni-Cr-W-Nb-Hf-V-C eutectic. The carbides were made by powder metallurgical methods. The phase composition of the carbide was determined by metallographic and x-ray structural analysis methods. The crystalline lattice parameter is studied at room temperature, the temperature coefficient of linear expansion at 373-1273°K. There is a minimum on the temperature curve, resulting from reversible phase conversions. There is a weakening of the total chemical bond upon alloying. Figures 3; references 12: 9 Russian, 3 Western.
[36-6508]

UDC: 621.762.5.001:539.4.42:620.18

DILATOMETRIC AND THERMOGRAPHIC STUDY OF REACTION SINTERING OF POWDERED TITANIUM NICKELIDE. I. SPECIFICS OF PRODUCTION OF POWDER TITANIUM NICKELIDE BY REACTIVE SINTERING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 83
(manuscript received 28 Feb 83) pp 31-36

MARTYNOVA, I. F., PETRISHCHEV, V. Ya. and SKOROKHOD, V. V., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] Since shape memory is manifested in the system Ti-Ni only by the Ti-Ni intermetallide, the presence of other phases is undesirable. The task of producing a porous material capable of recovering its shape by reactive sintering is thus reduced to the selection of characteristics of the initial materials and technological conditions such that specimens are obtained retaining their shape and dimensions after sintering and having the maximum content of Ti-Ni. The results of differential thermographic and dilatometric analysis show that the diffuse interaction upon sintering of an equiatomic mixture of powders of titanium and nickel passes through several stages: solid phase reaction diffusion; diffusion in the presence of a liquid phase formed as a result of contact melting; and a solid phase interaction. The phase composition of the sintering products depends on the porosity of the specimens. As porosity increases the material becomes more homogeneous, apparently a result of an increase in the true temperature reached in the specimen during sintering due to the change in balance of heat liberation and loss. Figures 2; references 15: 11 Russian, 4 Western.
[36-6508]

UDC: 621.762

MECHANICAL PROPERTIES OF COBALT-ZIRCONIUM CARBIDE MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 83
(manuscript received 18 Nov 81) pp 103-106

DEMIDENKO, N. I., VLASOV, A. S. and SKIDAN, B. S., Moscow

[Abstract] A study is presented of the mechanical properties of eutectic compositions based on ZrC-Co as a function of the diameter, length-to-diameter ratio and number of fibers of zirconium carbide per unit cross section. The specimens were obtained by directed cooling of a eutectic melt containing 10.2% fibers by volume in a corundum crucible. The microstructure was studied with a metallographic microscope and a scanning electron microscope. It was found that a decrease in the diameter of zirconium carbide fibers and an increase in the ratio of fiber length to diameter as well as the number of fibers results in an improvement in mechanical properties such as tensile strength, flexural strength, microhardness and elasticity modulus. Best mechanical strength figures were: σ_b=2.0±0.4 GPA, σ_f=2.6±0.5 GPA, obtained at fiber diameters 0.5 μm, l/d=73, number of fibers $20.2 \cdot 10^4$ per mm^2.
[36-6508]

UDC: 621.762.2

CONTINUOUS MOLDING OF PIPE FROM METAL POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 83
(manuscript received 24 Jan 83) pp 12-17

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[Abstract] The Belorussian Polytechnical Institute has developed a method and device for continuous molding of pipe from powders providing for joining of individual batches of powder together in the process of compacting and elimination of some of the shortcomings of the previous methods such as batch molding of powder and joining of briquettes. A diagram of the device and photomicrograph of the joint formed between two batches of different powders (iron and copper) are presented. The first batch of powder is compressed between the advancing ram and a metal plate which covers the outlet of the mold. After the first batch, the metal plate is removed and the friction between powder and mold must be sufficient to allow sufficient pressure to mold subsequent batches of powder. An experimental study is described of the unsteady portion of the continuous molding process as the pressure is applied. It is concluded that the forces are determined by the geometric parameters of the focus of compacting and deformation, the properties of the material being compacted and the friction at the boundary between the powder and the tool. Figures 4; references 11: 7 Russian, 4 Western.
[36-6508]

UDC 621.762.5:661.66.1:546.261

ELECTRICAL CONDUCTIVITY OF SELF-BONDED SILICON CARBIDE DOPED WITH BORON

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 83
(manuscript received 21 Mar 83) pp 69-73

GNESIN, G. G., SHIPILOVA, L. A. and KAS'YANENKO, A. A., Institute of Problems in Materials Science, UkSSR Academy of Sciences

[Abstract] A study was made of self-bonded polycrystalline silicon carbide, an n-type porous material produced by reactive liquid-phase sintering, for the purpose of determining the effect of its doping with an acceptor impurity such as boron on its electrical conductivity (resistivity). Specimens were produced according to standard technology, by impregnating a mixture of α-SiC and 30% petroleum coke powders with molten silicon at 2300°K in an inert atmosphere. One control specimen was not treated further, five specimens were heat treated at 2500°K in an inert atmosphere containing boron vapor. Another specimen, with 3 wt.% amorphous boron in the original mixture, was sintered at 2400°K in a nitrogen atmosphere. Another specimen was produced by impregnating the original mixture in an inert atmosphere containing boron vapor. Microstructural examination of such silicon carbide by layerwise electrolytic etching revealed a highly nonhomogeneous system containing a SiC" phase with $\rho \sim 10^{-1}$ ohm·cm in addition to the original SiC' phase (85% 6H grains + 15% 15R grains) with $\rho \sim 10^{-2}$ ohm·cm. The temperature dependence of electrical resistivity and of thermoelectric power, measured over the 300-1500°K range, indicates that the effect of doping becomes strong at high levels $n_B > 0.1\%$. This is attributable not only to formation of the more disperse B_4C^B phase, not detectable x-radiographically, but also to a higher concentration of free holes. These results, and calculations of the conduction activation energy, confirm earlier conclusions about the activity of boron. It also appears to be feasible to regulate the electrical resistivity of self-bonded SiC' over the 10^{-1}-10^3 ohm·cm range by varying the boron content. The SiC" phase with a continuous distribution of boron diffusing depthwise from a thin surface layer with high boron content can, at high doping levels, become a p-type material. Figures 3; references 16: 12 Russian, 4 Western.
[50A-2415]

UDC: 669.295.5:539.43:669.798

INFLUENCE OF HYDROGEN ON PROPAGATION OF FATIGUE CRACKS IN TITANIUM AND ITS ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian No 5, Sep-Oct 83 (manuscript received 1 Oct 81) pp 29-35

FISHGOUT, A. V. and KOLACHEV, B. A., Moscow Aviation Technology Institute imeni K. E. Tsiolkovskiy

[Abstract] A theoretical study is presented of the probability of dissolved hydrogen influencing the propagation of cracks in a metal with asymmetrical cyclic loading. The loading parameters for which this influence is possible are estimated. Three versions of interaction of hydrogen and cyclical mechanisms of crack growth are suggested: 1) simple addition of the rates of cyclical and hydrogen growth mechanisms; 2) embrittlement due to cyclical deformation of the material in advance of the crack tip, facilitating crack growth by the hydrogen mechanism; and 3) hydrogenation with ascending diffusion of the volume of metal in advance of the crack tip, accelerating propagation by the cyclical mechanism. These versions are studied for VT6 alloy. The authors conclude that acceleration of cyclical growth of a crack due to hydrogen embrittlement of the material is most probable. The crack growth rate by the hydrogen-cyclical mechanism is 1 or 2 orders of magnitude higher than for the purely cyclical mechanism. These results serve as a basis for systematic experimental work to determine the influence of hydrogen dissolved in titanium alloys on the rate of development of cracks in these alloys under cyclical loading. Figures 3; references 14: 8 Russian, 6 Western. [33-6508]

UDC 669.295:666.046.516:539.67

IMPURITY RELAXATIONAL SPECTRUM OF INTERNAL FRICTION IN TITANIUM BETA-ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 56, No 6, Dec 83 (manuscript received 24 Mar 83) pp 1146-1151

GRIDNEV, V. N., KUSHNAREVA, N. P., PECHERSKIY, V. S. and YAKOVENKO, P. G., Institute of Metal Physics, UkSSR Academy of Sciences

[Abstract] Rather little study has been made of internal friction in titanium beta-alloys. The present article reports on results of experiments with titanium alloyed with 20 or 33% Mo and 20 or 27% Nb by weight, melted by an electrode arc method using a tungsten electrode. Metal rods were formed and annealed in a vacuum at 800°C, producing rods 0.8-1 mm by 100 mm with 75% deformation. Previous difficulties of analysis were avoided by a graphic approach showing ideal and actual curves of internal friction and by dividing the peaks into five values representing local impurity states related to the molybdenum in the alloy. Further study of the role of nitrogen in these relaxational spectra is needed. Results indicated that the location of peaks is dependent on the type and concentration of alloying additives. Activation energy for oxygen diffusion in the beta-phase of the tested alloys was $9.2\text{-}11.3 \cdot 10^{-4}$ J/mole. Computer calculations were possible for determining the spread of elementary peaks during decomposition of complex impurity spectra. Figures 4; references 12: 6 Russian, 6 Western.
[62-12131]

UDC 669.295'71:621.785.78

EFFECT OF DEGREE OF COLD PLASTIC DEFORMATION ON AGING PROCESS OF VT16 TITANIUM ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 56, No 6, Dec 83 (manuscript received 30 Mar 83) pp 1165-1169

MAL'TSEV, M. V. and KASHNIKOV, N. I., Gorky Polytechnical Institute imeni A. A. Zhdanov

[Abstract] Aging decomposition processes in deformed VT16 alloy products differ from those in the non-deformed alloy. The present article reports on effects of deformation on VT16 alloy after tempering at 750°C where the alloy structure contains both a primary alpha-phase and a mechanically unstable beta-phase. Compression deformation of 1 to 15% was followed by heating to 100-550°C at 3°/min, followed by water cooling. Phase and dilatographic analysis and hardness tests were conducted. Deformation resulted in beta-alpha" transformation producing alpha"-martensite, as well as distortion of the beta-phase matrix. The dependency between percentage of deformation and temperature of the above transformation and its reverse alpha"-beta transformation are discussed. As the degree of deformation increases from 3 to

15%, the compression zone shrinks and the temperature at which compression begins increases from 220 to 350°C, while the effect of compression becomes less. Form memory is reflected in the phase conversion and reconversion at less than 2% deformation. Increased deformation after tempering suppresses low-temperature reverse martensite transformation, and phasal transformations under constant heating are related to decomposition of the alpha"-phase. Figures 5; references 7: all Russian.
[62-12131]

UDC: 669.295.017:621.73.01

HYDROGEN PLASTICIZING OF TITANIUM ALLOYS UPON HOT DEFORMATION

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 83 (manuscript received 20 Jul 82) pp 92-96

KOLACHEV, B. A. and NOSOV, V. K., Moscow Institute of Aviation Technology, Department of Metallography and Hot Working of Metals

[Abstract] Introduction of hydrogen to titanium alloys decreases the resistance to deformation during hot pressure working. The mechanism of hydrogen plasticizing is that hydrogen in high aluminum alloys hinders the formation of the brittle α_2 phase, increases the quantity of cubic β phase and increases the diffusion mobility of atoms of the phases which make up the alloy. Hydrogen plasticizing is apparently an unusual manifestation of the ordinary phenomenon of superplasticity. It is unusual in that it appears at temperatures 100-150°C below the superplasticity temperature of ordinary titanium alloys and at deformation rates 1 to 2 orders of magnitude higher than superplastic flow of these alloys. A technology has been developed for isothermal stamping of the alloys VTZ-1 and VT18U at lower than usual temperatures. Forgings produced by a technology including hydrogenation, plastic deformation and vacuum annealing have shown good properties. Figures 5; references 10: 9 Russian, 1 Western.
[31-6508]

UDC: 621.785.53

INTENSIFICATION OF DIFFUSION SILICIDING OF TITANIUM ALLOY

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 83 pp 104-107

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[Abstract] Experiments involving diffusion saturation of the titanium alloys VT1-0, OT4 and VT14 with silicon confirmed the intensifying effect of this additive when mixed with copper powder. Intensification is manifested at saturation temperatures above 802°C, when liquid is present in the mixture. The thickness of the diffusion silicide layers depends on the content of

copper in the mixture and of the treatment temperature, increasing with an increase in either factor. Copper content should not exceed 25% of the mass of the mixture, since otherwise the mixture cakes badly and surface quality deteriorates. The phase composition of the silicide layers produced was studied by x-ray structural and microscopic x-ray spectral analysis. The major phase present was $TiSi_2$. The coating systems developed were tested under high-temperature oxidation conditions and in H_2SO_4 and HCl. They can be placed in the following sequence of increasing heat resistance: Si, Si-Cu-Sn, Si-Cu-Ti and Si-Cu-Zn. The greatest corrosion resistance in 80% sulfuric acid was that of Si-Cu-Zn coatings. Figures 2.
[31-6508]

UDC: 621.78.79:620.17:620.18

STRUCTURE AND PROPERTIES OF VT22 ALLOY AFTER THERMAL CYCLING TREATMENT AND ANNEALING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 83 pp 54-56

LYASOTSKAYA, V. S., LYASOTSKIY, I. V., FEOKTISTOVA, Ye. K., MALEYEVA, N. V., Moscow Aviation Technology Institute, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin, All-Union Institute of Aviation Materials

[Abstract] A study is made of the influence of thermal cycling and subsequent heat treatment on the structure and mechanical properties of VT22 alloy, which completes $\alpha \rightarrow \beta$ polymorphous conversion at 890°C. Hot rolled bars 22 mm in diameter were studied after preliminary annealing at 1050°C for 1 hour and cooling in air to produce a large grain structure (mean grain diameter 500 μm). Thermal cycling consisted of heating the specimens to 950°C with subsequent cooling to 600°C for 1, 5, 10 or 20 cycles, with cooling either in air or in the furnace, final cooling in air. The structure was studied by metallographic and x-ray structural analysis methods. Thermal cycling with subsequent cooling produced a polygonized or comparatively small grain recrystallized structure. Increasing the number of cycles, decreasing the cooling rate between cycles and increasing the length of final annealing all facilitated spheroidization and increased thickness of α phase plates. Thermal cycling with subsequent annealing increases ductility and impact toughness of this material. References 8: all Russian.
[34-6508]

NEW WELDING PROCESSES

Moscow EKONOMICHESKAYA GAZETA in Russian No 50, Dec 83 p 2

[Article by Academician B. Ye. Paton, president of USSR Academy of Sciences, program director for welding engineering: "New Welding Process"]

[Text] Domestic science and technology has led our country's welding engineering to foremost positions in the world both in scale and level of development. In recent years a number of problems have been solved in the field of theory formation, manufacturing methods and assembly of welded metal works for various purposes. Significant changes have occurred in designing methods, qualities of steels used and shapes of rolled stock. They have had a favorable influence on the performance and quality of the many products of mechanical engineering. New welding processes have played a distinct role in reducing the construction time of pipelines (particularly the Urengoy-Uzhgorod export gas pipeline) and a number of major installations of ferrous and non-ferrous metallurgy, petroleum chemistry, nuclear power and transportation.

More than 400 scientific research institutes (NII), design bureaus (KB), higher educational institutions and plant laboratories are conducting scientific research in the field of welding and developing new materials, equipment and technologies. Over 110 specialized enterprises and shops presently provide mass production of welding equipment and materials. In the last 25 years the production of welders increased about sixfold and that of welding wire and rods increased almost fourfold. Welded construction output increased from 5.9 to 74.2 million tons. Now in the country there are 1.4 million welding stations. The level of welding mechanization has risen from 11 to 56 percent.

In the 11th Five-Year Plan dozens of enterprises and organizations of various sectors are busy implementing a scientific and technical program "To develop highly efficient technological processes for welding, surfacing, brazing and thermal cutting and to create for them highly efficient production equipment, welding materials and means of monitoring and control." The realization of its programs will make it possible to reduce outlays and improve labor conditions considerably at many process stages and save a large amount of material and fuel and energy resources.

Priority of Soviet Science

Many industrially developed capitalist countries do not stint their acquisition of Soviet licenses for welding equipment and materials. Our leadership in many positions in this field is universally recognized.

The scientific and technological program focusses on collectives of scientists, designers and production workers for creating even more improved innovations. Much has been done since the five-year plan began.

For example, last year a unique 72-electrode welder for electroslag welding of heavy guage metal was introduced at the Volgodonsk "Atommash." With its help a set of machining attachments has already been manufactured for a unique 15,000 ton-force press. Its main purpose is machining large nuclear reactor components weighing up to 400 tons.

Two synchronous electric drives move the assembly along rails. Thus, it is possible to weld seams of practically any length. The adjustable parts of the apparatus can accept pieces of work with up to an 8.5-meter diameter. A high-quality joint of the parts is ensured with the three-meter-thick walls made of high-strength steel. The assembly has the potential capability of welding metal four meters thick. Simultaneous working for two joints at once is envisioned. An information measurement system using microprocessors monitors the precise observance of the operating conditions. This task was carried out by collectives of the Electric Welding Institute imeni Ye. O. Paton, the Central Scientific Research Institute of Heavy Machinery and the All-Union Planning, Designing and Technological Institute (VPKTI) "Atomkotlomash". The savings from the assembly is estimated at 846,500 rubles.

Technological welding processes have been devised in our country which assure the production of permanent joints of practically all existing metals, alloys and plastics. Along with the traditional methods, new highly productive methods have been placed at the service of technical progress: electron-beam welding, plasma-arc welding, high-frequency welding, explosion welding, friction welding, solid-phase welding, electrohydraulic and a number of others.

Economical and efficient welding and fusing wire and tape, alloy welding wire with rare-earth elements, activated wire and new fluxes have been created. The preeminence of Soviet science on many positions in this area is also indisputable.

The following examples attest to how the improvements made to welding equipment and materials benefit the national economy. The new technological process of explosion welding of current-carrying elements was used on 16 of the country's electric railways. Almost 1.5 million rubles worth of resources were saved.

The new technology of argon-arc surfacing of internal combustion engine aluminun pistons at the "Kievtraktorodetal'" Association yields an annual savings of 5 million rubles. The piston life has increased 2-2.5-fold without requiring the addition of expensive materials.

The cost of powerful diesel crankcases fell to one-eighteenth of its previous level and over 300 welders were freed as a result of the introduction of a specialized system of continuous flash resistance welding of parts with a large cross-section. The many hour operation of annealing treatment of the pieces after welding has been eliminated.

Before the end of the five-year plan, in accordance with one of the program's tasks, technological processes are to be introduced for mechanized gas-shielded and open-arc welding of activated wire. This increases labor productivity by 1.5-2-fold and decreases expenditure of welding materials by 10-30 percent. In 1983 scientific research on this subject is being completed and in 1984 the technological documentation for experimented industrial production will be distributed.

Intersectorial Nature

One probably cannot find any branch of industry in which welding processes have not been used. These methods are used only in plant shops and building but also in underground and underwater operations. Welding units are being taken along on space flights.

Many ministries and departments both produce and operate this equipment. Needless to say, it is not without difficulties and discrepancies. Figuratively speaking, the scientific and technical program is called upon to provide permanent connections for these intersectorial joints.

A scientific council for welding operates under the State Committee for Science and Technology (GKNT). Its activities are oriented toward acceleration of scientific and technological progress and shortening reduction of path from idea to introduction. The current state of welding in our country and abroad is systematically analyzed. In addition, much work is being done by the coordination council of the Electric Welding Institute. These agencies, made up of leading scientists and representatives of various ministries and departments, exercise control and ensure the interaction of all participants.

The progress of task fulfillment is recorded by statistical accountability. Missing deadlines can involve sanctions against the executives, including deprivation of bonuses. It appears that after the well-known resolution of the CPSU Central Committee and the USSR Council of Ministers came out concerning speeding up the scientific and technical progress, the role of the program coordinators will increase markedly. The planning mechanism will be used fully and executive accountability will increase.

Unfortunately, not all the program's tasks are able to be fulfilled right on time and to the full extent. I will cite a typical example. In 1984, the Pskov Heavy Electric Welding Equipment Plant of the Ministry of Electrical Equipment Industry (Minelektrotekhprom) must product an installed series of machines for flash resistance welding of tee joints of large-series components of reinforced concrete structures with rods up to 20 mm in diameter. The

prototype has been approved by the interdepartmental commission, documentation prepared and corrected, but the enterprise on various pretexts is not getting down to business and pleads overwork by other orders.

But the issue here is equipment for which the construction industry is waiting and which promises great savings in labor and material resources. The task directly conforms to the enterprise's production structure. One wants to believe that the VPO (All-Union Production Association) "Soyuzelektroterm" and local party organs will take the necessary steps to eliminate this procrastination.

The introduction of nondestructive means of welding joint quality control remains a weak point for the time being. The necessary elaborations have been made at the highest level. However, the Ministry of Instrument Making, Automation Equipment and Control Systems (Minpribor) is dragging out modernization of its enterprises, thus postponing real implementation of series-production of equipment in short supply. The expansion of the Kishinev Scientific Production Association (NPO), "Volna", designated for this production, is unsatisfactory. As a result, the quality of welded structures is suffering.

The effect of introducing new welding materials would be even greater with an aggressive and motivated stand by the USSR Ministry of Ferrous Metallurgy (Minchermet). These items, ancillary from the ministry's viewpoint, directly affect the manufacturing quality and time of machine building production an and the installation of many projects.

It seems that such deficiencies are removable. It is enough to exhibit the proper efficiency and exacting requirements and to monitor earlier adopted decisions more closely.

Prospects of Development

Intensification of production pushes more and more new problems on the agenda. It is clear that in the USSR, just as in other countries, steel smelting and rolled metal production, for example, will be significantly limited in the future. The trend in ferrous metallurgy will be mainly towards a sharp increase in the quality and expansion of variety of rolled metal.

Does this signify a slowing down in the development and a stabilization of welding production? Absolutely not. Although the production volume, and the quantitative and weight growth of welded structures will inevitably slacken, an increase in production output will be assured in machine building and metal working due to the considerable decrease in the metal content of the products.

The proportion of sheet rolled metal will increase sharply. Cold-rolled sheets with protective coating and with special properties, heat-hardened rolled metal and roll-formed sections will be used at leading rates. Rolled metal, differentiated by effective strength characteristics, will be widely used in construction as well as in machine building. Vast potentials are hidden here.

In spite of the accelerated development of resistance welding and new, special welding methods, fusion welding still retains the main share in spheres of traditional application. Furthermore, we take into account the data on the extent, shape and cross-section of the welds. For example, according to data on one of the inspections conducted, half of all the continuous welds were less than 300 mm long. If one were to count the welds up to 500 mm in length and also discontinuous welds, they would account for 70 percent of the total. Consequently, the development of equipment for automatic welding of short and discontinuous welds must be a top priority.

One can also make an important conclusion from the fact that in the structure of joints according to type, also about 70 percent are angular welds. Hence, the expediency of developing special equipment for making them, with the use of simple joint tracking systems using self-copying electromechanical, electromagnetic and other systems.

Among the large group of fusion welding methods, the largest amount of work will be performed by semiautomatic and automatic gas-shielding welding. Already at the present time CO_2-shielded welding at the country's leading enterprises has practically replaced gas and manual welding of metal 1-3mm thick. In manufacturing structures from metal of average thickness and greater, CO_2-shielded welding is also being used instead of manual arc welding, but using somewhat larger diameter wire.

A great effect will be obtained by the wide use of welding using gas mixtures based on argon, primarily two-component mixtures of argon and carbon dioxide and three-component mixtures of argon, carbon dioxide and oxygen. Four-component mixtures based on helium warrant increased attention. Laboratory tests show that it is possible to raise significantly the upper limits of welding current and, in so doing, ensure good forming of welds.

Submerged arc welding will retain and even increase its importance. It is an all-purpose and most economical method of mechanized arc welding, possessing broad technological possiblities, high productivity and providing excellent quality.

The use of single electrode welding in the future should be kept to a minimum, i.e., only for those instances when the use of mechanized methods would be technically or economically unsuitable.

Undoubtedly, the role of arc deposition methods will grow significantly, including plasma-arc deposition, not only as a means of restoring worn components but also, considerably more effectively, for obtaining especially wear resistant components during their manufacture. Fillers with highly effective substitutes for tungsten, cobalt and other critical materials will find widespread usage. Plasma spraying--a process with great potential and largely unused possibilities--will receive further development.

In the power and chemical machine building industry and in all areas of new technology, the use of electron-beam welding must expand considerably in the production of heavy equipment. Its technology has become so complete that its assimilation in production poses no serious difficulties.

One can confidently say that the next decade will be marked by the introduction of continuous emission laser technology into welding production. It is also possible that the laser beam will replace the arc in certain traditional areas of use.

Flash-butt resistance welding has great prospects in the production of large diameter pipes, in construction of main pipelines and maritime structures, and in heavy and transport machine building. Its development will go the way of searching for ways to lower metal losses and also developing new automated systems based on sophisticated electronic technology for monitoring the process and verifying the basic parameters.

A new significant stage in the development of welding engineering will be the assimilation of series-production and large scale introduction of robots and robot-operated technological complexes. The problems of comprehensive automation of the manufacturing of variable nomenclature leads us to the necessity of creating flexible automated welded works with robot-automated conveyance, assembly, welding, quality control and mechanized fabrication, as well as conveyance equipment. The problems of developing the technology and mathematical support of versatile automated welding works as well as the problems of the optimal configuration of the production and technological process under conditions of sharply reduced numbers of personnel must be resolved immediately. Solving these problems will make it possible to increase utilization of welding equipment severalfold and to achieve a substantial increase in labor productivity.

Extensive prospects for further development are opening up before Soviet welding science and technology and welding production. This trend of scientific and technological progress has a tremendous future.

PHOTO CAPTION

[Photo not reproduced]: The Kakhovak Electric Welding Equipment Plant produces "Styk" automated units for welding pipe for gas pipelines. A specialist manually welds one joint per shift, while the complex welds over 20. In the photo the assembly manufacturing shop.

12567
CSO: 1842/44

UDC: 621.791.754.293:621.774.21

ARGON-ARC TREATMENT OF SEAM BOUNDARIES IN LARGE DIAMETER WELDED PIPE OF 09G2FB AND Kh-70 STEELS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 83
(manuscript received 6 Jan 83; in final form 21 Jun 83) pp 67-68

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[Abstract] A study is made of the influence of argon-arc welding on the structure, hardness and mechanical properties of welded joints in large diameter gas pipe. Specimens were taken from 1420-mm-diameter welded pipe. Argon-arc treatment was performed with and without preliminary heating. Heating was performed by playing a burner back and forth over the specimen. In both cases tungsten electrodes 4 mm in diameter were used, current 210-230 A, voltage 20-23 V. Plasticity of the welded joints in the initial state and after argon-arc treatment was estimated from the results of bending tests at +20 to -80°C. It was found that the plasticity of the welded joints of 09G2FB steel pipe in the initial state was 6.5-10.0%, Kh-70 steel - 5.3-8.5%. After argon arc treatment with and without heating, δ of 09G2FB steel pipe was 6.5-12.0%, Kh-70 pipe - 6.5-12.3%. The results allow argon arc treatment with heating to be recommended for elimination of deep notches. Figures 2; references 3: all Russian.
[35-6508]

UDC 621.791.4:589.378.3:669.295

EFFECT OF OXIDE FILMS ON REACTION OF CONTACT SURFACES IN DIFFUSION WELDING OF TITANIUM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 83 pp 4-5

PESHKOV, V. V., candidate of technical sciences, PODOPRIKHIN, M. N. and MILYUTIN, V. N., engineers, Voronezh Polytechnical Institute

[Abstract] Numerous works have attempted to determine the behavior of titanium oxide films during diffusion welding. The present study reports on kinetics of previously oxidized surfaces. Results showed that increasing oxide film

thickness increased the incubation period that preceded formation of a durable bond. At welding temperatures of 575-600°C this effect had a linear dependency only to a certain thickness, after which the time required for a durable bond increased more rapidly than oxide thickness growth. Increased welding pressure and subsequent deterioration of the protective properties of the atmosphere brought the need for higher welding temperatures. Oxide removal and resulting metal deformation must be taken into account in projecting the durability of weld seams. Figures 3; references 6: all Russian.
[45-12131]

UDC 621.791.011

WELDING CAPABILITY OF LARGE FORGINGS OF ALLOY 1201

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 83 pp 19-21

MIRONENKO, V. N., candidate of technical sciences, SOSHKO, I. F. and KAZAKOV, V. A., engineers

[Abstract] Recrystallization after tempering causes formation of a coarse granular structure with granules perpendicular to the forge stress orientation. The present study reports on the implications of this factor for bonding details of alloy 1201. Templates were cut from forgings, tempered and artificially aged and then measured for temporal resistance to failure, impact strength and other durability factors. Results showed that in automatic argon-arc welding, vertical joints were inferior to longitudinal joints in all these properties. Metallographic analysis also showed the presence of coarse melted boundaries in large granules of proximity zones of perpendicularly oriented joints. While prior grinding somewhat increased durability, it remained below that of lobar joints with low viscosity criteria. High-energy welding by impulse arc electrode and electron arc produced significantly better mechanical properties in vertical joints due to reduced heat accumulation and thermal impact on the base metal during welding. Figures 4; references 3: all Russian.
[45-12131]

UDC: 621.791.754'293.052.4:669.295:620.196.9

SALT CORROSION OF AT3 ALLOY AND WELDED JOINTS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 83 pp 69-70

LANGER, N. A., doctor of technical sciences, BLUASHCHUK, V. Ye., candidate of technical sciences, ONOPRIYENKO, L. M., engineer, SHELENKOV, G. M., candidate of technical sciences

[Abstract] Studies were performed on specimens measuring 300 x 125 x 25 mm of hot rolled AT3 sheet titanium alloy containing,%: Al 3.1, Cr 0.4, Fe 0.45, Si 0.29, O 0.084, H 0.002, N 0.01, both as delivered and after annealing

at 650°C, 1 hr, cooled in air. Specimens were welded by a mechanized argon arc machine with an infusible 10-mm-diameter electrode in three passes. Specimens were also manually welded under argon with X-shaped finishing of edges and through a slit gap with an infusible 5-mm-diameter electrode and with an electrode of the same diameter of alloy SP2V. Cylindrical specimens were made to determine the sensitivity of AT3 alloy and the welded joints to high temperature salt cracking. The tests showed that the worst salt cracking resistance was that of welded joints made by welding through a slot gap. Annealing leads to an increase in long-term strength of welded joints and a decrease of long-term strength of the base metal. The hydrogen and oxygen content in the seam metal before and after testing for salt corrosion were determined by vacuum melting and it was found that they practically did not change. Figures 2; references 5: all Russian.
[35-6508]

UDC: 621.791.72.011:669.715

ELECTRON BEAM WELDING OF DISSIMILAR ALUMINUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 83
(manuscript received 28 Mar 83) pp 18-25

BONDAREV, A. A., CHERNOV, V. Yu., LOVOVSKAYA, A. V., candidates of technical sciences, NOVAKOVSKAYA, A. A., KAYDA, T. N., engineers, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] A study is made of electron beam welding of joints in dissimilar deformed and cast aluminum alloys. Before welding, plates 20 mm thick of the alloys tested were in thermally hardened, hardened and artifically aged, cast and annealed or hot rolled states. The short-term strengths of the joints indicate that at room temperature the properties of the joints are similar to those of the weaker of the two alloys welded. Specimens usually ruptured outside the seam area. Results of the distribution of elements across the axis of the seam were obtained as continuous diagrams covering areas of base metal, fusion and seam areas near the fusion area on both sides, as well as the central portion of the seam. The distribution diagrams are practically identical for iron, manganese, nickel and silicon, with maximum content in individual intermetallides, frequently of complex composition. Analysis of the distribution of the major alloying elements allows estimation of the homogeneity of various sections, the composition of individual phase components and determination of the fraction of each of the alloys welded in the metal seam. Figures 4; references 2: both Russian.
[35-6508]

UDC 621.791.753.5.053.55-462:629.17:621.039.5

USE OF NEW WELDING MATERIALS FOR CIRCULAR SEAMS IN HIGH CAPACITY NUCLEAR POWERPLANT REACTOR SHELLS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 83
(manuscript received 12 May 83) pp 38-42

GORYNIN, I. V., corresponding member USSR Academy of Sciences, IGNATOV, V. A., doctor of technical sciences, TIMOFEYEV, B. T. and SHKATOV, Yu. I., candidate of technical sciences, Leningrad

[Abstract] Results are presented from statistical processing of the results of mechanical testing of the metal of seams welded using two combinations of welding materials: type Sv-10ZhGNMA-A wire and AN-17M flux and type Sv-08ZhGNMTA wire and NF-18M flux. A test of agreement of the empirical distributions obtained from the experimental data with the Weibull, normal, log-normal and exponential distributions showed that the normal distribution can be used to describe the results of the tests. A statistical comparison of the distribution of mechanical properties under one-time loading with the required level of these properties in accordance with the design and technological documentation is presented. The required level of properties at 20°C is achieved with a high degree of reliability. However, at 350°C, the required level of short-term tensile strength is only 50% achieved by the first welding method, and the level of yield point and relative elongation, only 90%. When the second method is used, the level of mechanical properties is achieved with good probability. The superiority of the second method is particularly evident in tests of impact toughness. The second method also provides best agreement with the required value of critical brittleness temperature for seam metals in VVER-1000 nuclear reactor apparatus (not over 0°C). The second method provides a welded seam which better resists the propagation of fatigue cracks. Figures 6; references 14: all Russian.
[35-6508]

MISCELLANEOUS

UDC: 669.046.56

SORPTION AND DESORPTION OF CARBON MONOXIDE FROM MELTS OF IRON COBALT AND NICKEL AT 1800-2000°C AND $P_{CO} \leq 9.8 \cdot 10^4$ Pa

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 2 Mar 83) pp 39-44

BURTSEV, V. T., Moscow

[Abstract] An analysis of the literature indicates that there is no single understanding of the mechanism of interaction of CO with iron at traditional temperatures, and that there are practically no data at all at elevated temperatures around 2000°C. The purpose of this study was to fill this gap. The method of melting in the suspended state was used, the material for the study being iron containing (in 10^{-3} wt.%) 5 Si, 9 Mn, 8 P, 9 S, 2 Al,tin, 9 O and 60 C, plus an iron-carbon-oxygen alloy containing 3.3 O and 500 C, as well as electrolytic cobalt and nickel containing (also 10^{-3} wt.%) 10 Si, 1 Mn, 5 P, 50 S, 10-40 O and 4 C. All initial metals and alloys were remelted four times in an electron beam furnace under a vacuum of $133 \cdot 10^{-5}$ Pa. Two series of experiments were performed to study sorption and desorption. The data obtained from sorption and desorption of carbon monoxide by iron-based melts indicates asymmetry of these processes and assistance of additional resistance to the transport of the reaction components through the vapor-gas shell.
[42-6508]

UDC 669.782

AUTOGENERATOR METHOD OF MEASURING MEAN ELECTRICAL RESISTANCE OF MONOCRYSTALLINE SILICON

Moscow TSVETNYYE METALLY in Russian No 11, Nov 83 pp 46-47

VOLKOV, L. I., DANKOVSKIY, Yu. V., KUDIN, A. V. and LEVINZON, D. I.

[Abstract] Measurements of magnitude and curve form for mean electrical resistance along the growth axis of monocrystalline silicon are required prior to marketing products of the material. The current double-probe method requires much labor and the tested material cannot be used for actual products. The authors designed and tested a device for these measurements that employs three electrodes. The middle (mobile) electrode is connected to

a constant frequency autogenerator, and this feature permits measurement of geometric and electrical resistance values of semiconductors where the effective volume of the cast crystals is known. The arc of the central electrode can be adjusted without changing the side electrodes or the inter-electrode spacing. Experimental tests with monocrystalline silicon in 25-100-mm-diameter castings showed accuracy within $\pm$ 10%, and two years of use have demonstrated the reliability and stability of the measuring device. Best results were obtained with castings from smelts or constant flow processes. Figures 2.
[61-12131]

UDC 669.295

SELECTING MATERIALS FOR EQUIPMENT IN MAGNESIUM-THERMAL TITANIUM PRODUCTION

Moscow TSVETNYYE METALLY in Russian No 11, Nov 83 pp 43-44

NECHAYEV, N. P., KOCHERGIN, V. P., PUTINA, O. A. and BONDAREVA, E. P.

[Abstract] Selection of construction materials to work in a titanium tetrachloride gas atmosphere at 1123°K as found in magnesium-thermal production requires consideration of corrosion, durability and microstructure parameters. The present article reports on studies of Ti, V, Cr, Mn, Fe, Ni, Cu, Nb, Mo, Ag, Ta, W and Pt samples after 6 hours in a 1:10 $TiCl_4$: argon or pure argon atmosphere at 1123°K. Multivalent metals with minimal inter-atomic spacing and high concentrations of collected valent electrons, in this case Cr, Mo and W, were found to have superior hardness and microhardness. High-temperature structural changes brought losses in durability. For a first group, consisting of Ti, V, Fe, Ni, Cu, Ag, Pt and Mn, with recrystallization at less than 1123°K, increased granule size and reduced elongation of granule limits were noted. Corrosion tests indicated that iron and manganese samples suffered pitting with less loss in durability compared to other tested metals. Figures 1, references 6: all Russian.
[61-12131]

UDC 669.859'1'25'3'296.538.22

STRUCTURE AND MAGNETIC PROPERTIES OF SINTERED $Sm(Co,Fe,Cu,Zr)_{7,6-7,8}$ ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 56, No 6, Dec 83 (manuscript received 17 Jan 83) pp 1108-1117

LINETSKIY, Ya. L., SAVICH, A. N., KNIZHNIK, Ye. G., KOROVYATSKAYA, M. V., MENUSHENKOVA, N. V. and POLUNIN, V. V., Moscow Institute of Steel and Alloys

[Abstract] Sintered alloys with the composition Co-25.5%, Sm, 8% Cu, 15% Fe and 1.5% Zr are known to have coercivity of 4.4-5.6 kA/cm, residual induction of 1.05-1.15 Tl and maximum energy production of 240 kJ/m^3. The present article reports on study of the impact of thermal processing on structure and magnetic properties of dispersion-hardened Sm-Co-Fe-Cu-Zr alloys for permanent magnets with high coercivity and magnetic energy. The cubic alloy samples were roasted in a vacuum at 1210°C for 30 minutes, then homogenized for 3 hours at 1180°C, cooled in helium and treated at 800°C for 1 to 24 hours. Final cooling was either by refrigeration or by a gradual process, 1 degree/minute, to 400°C. Results showed that low temperature thermal treatment had little impact, and reached 1.14 Tl. Rapid cooling increased coercivity from 0.4 to 1.2 kA/cm. Loops of hysteresis after gradual cooling were typical for homogeneous fixing of magnetic domain boundaries. Minor irregular plate flaws were noted. Increasing processing time to 24 hours brought growing brittleness to the cellular structure and wider coherent boundary separations in the alloy. Rapid cooling in this variant resulted in coercivity one or two orders less than gradual cooling produced. Figures 5; references 23: 10 Russian, 13 Western.
[62-12131]

UDC: 669-419

PLASTICITY AND FAILURE OF MULTILAYER METALS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 30 Jun 81) pp 117-123

YAVOR, A. A., Volgograd

[Abstract] Studies of the mechanical properties of multilayer steels in previous works have recorded a significant increase in plasticity and fracture resistance, explained by the reliable protection of the surface of the steel with martensite structure from damage and a decrease in the level of local peak stresses in the structure of the steel. The former factor stabilizes the properties of the hardened steel, the latter increases ductility somewhat, particularly at high concentrations of carbon. The creation of plastic surface layers firmly bonded to the reinforcement with no crack type defects at the division boundary decreases surface tension and makes it easier for dislocations to reach the surface. If there are no stress concentrations at the boundary between layers, plastic flow of a multilayer

specimen begins only after the stress in the reinforcing layer reaches the yield point of the reinforcing material, after which slipping may develop in the matrix grains. The plasticizing effect of the deformation interaction of the components in multilayer metals with high strength reinforcement thus results from an increase in stresses in the slipping planes of the reinforcing layer, as a result of the concentration of stresses at the edge of slipping planes which reach the boundary between layers. The strength of a multilayer specimen of this type is determined not only by the strength of the reinforcement, but also by the properties of the matrix material such as its strength and capacity for uniform deformation and the volumetric ratio of the components and thickness of the matrix layer. Figures 4; references 18: 15 Russian, 3 Western.
[42-6508]

UDC: 537.311.3:539.23:546.82

STRUCTURE AND ELECTRICAL PROPERTIES OF THIN TITANIUM AND TITANIUM OXIDE FILMS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov-Dec 83 (manuscript received 10 Nov 80) pp 59-63

OSIPOVA, G. I., PROTSENKO, I. Ye., SHAMONYA, V. G. and YAREMENKO, A. V., Kiev, Sumy

[Abstract] The phase composition and electrical properties of titanium and titanium oxide films produced under a vacuum of 10^{-3}-10^{-5} Pa are presented. Studies of the phase composition and structure of the films were performed by electron-optical methods. The distance was measured in the process of condensation on polished glass plates with fused molybdenum rod electrodes. The studies indicate conditions of formation of impurity face-centered cubic phases and allow determination of the mean free path length and coefficient of grain boundary scattering in freshly condensed titanium film, as well as the width of the forbidden zone of the titanium oxide semiconductor. Figures 4; references 9: 4 Russian, 5 Western.
[42-6508]

UDC 669.017:539.52

EFFECT OF MECHANICAL DEFORMATION PROCEDURE ON MECHANICAL PROPERTIES AND STRUCTURE OF SUPERPLASTIC ALLOYS Zn+22%Al AND VT9

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 6, Nov-Dec 83 (manuscript received 12 Oct 81) pp 158-162

GRESHNOV, V. M., Ufa

[Abstract] Considerable study has been made of rheological and structural aspects of superplastic deformation during uniaxial stretching, but little attention has been given to the mechanical deformation procedure studied here as it affects mechanical properties of fine crystalline materials. The two-phase industrial titanium alloy VT9 and Zn+22% Al were homogenized and tempered in water after heating to 350°C, then annealed at 250°C for 2 hours. Deformation was by stretching, pressure and general uneven compression. The mechanical deformation procedure was studied in relation to the coefficient of sensitivity to rate of deformation. Results indicated an increase in granule size brought on by deformation itself. This result was verified by 5 series of experiments using VT9 and 3 with the ZnAl alloy. The granule growth and the impact of deformation procedure on the rate of true flow tension contradicted earlier findings. Compression was also found to be more effective in increasing granule size than stretching. Further theoretical and experimental research is recommended. Figures 4; references 10: 9 Russian, 1 Western. [60-12131]

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